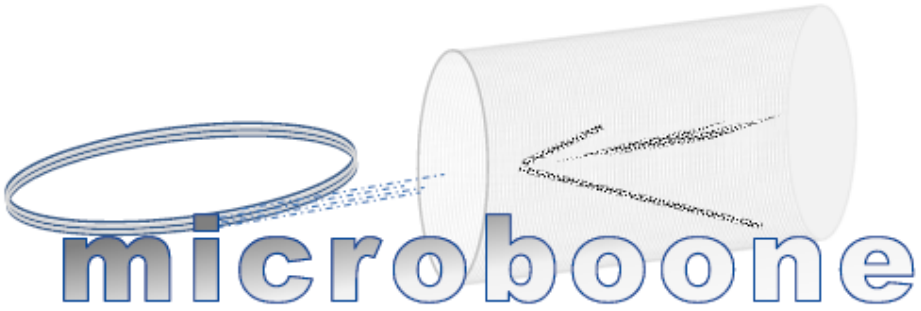


MicroBooNE Update for FNAL PAC

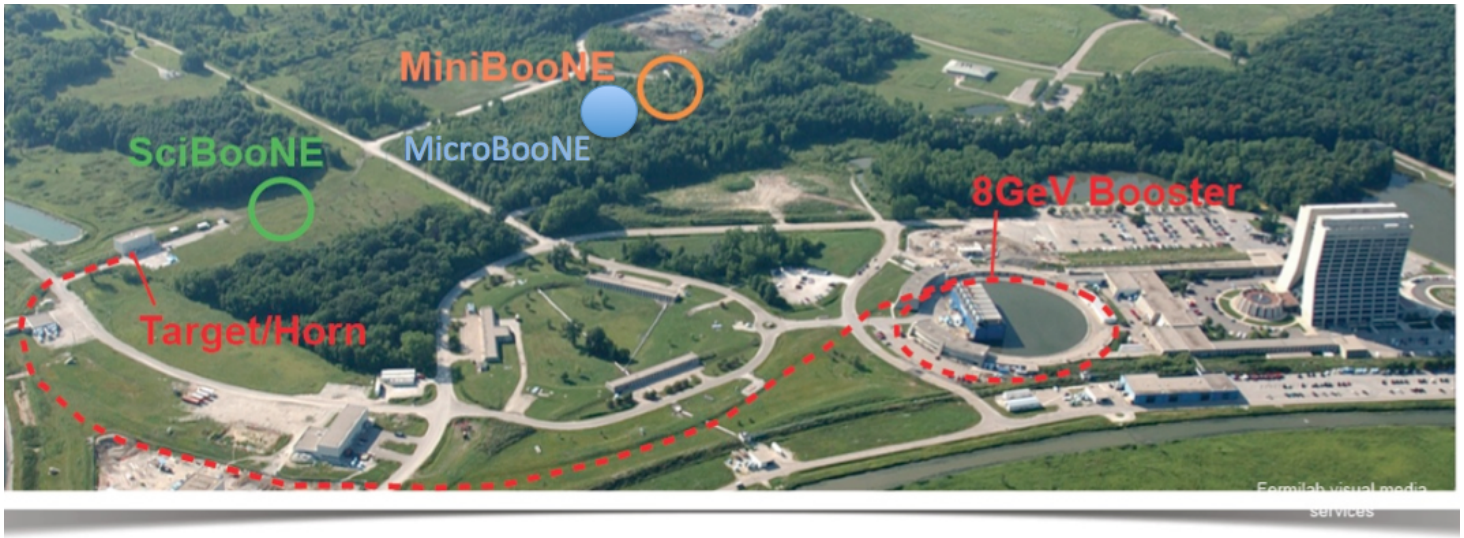
Bonnie Fleming

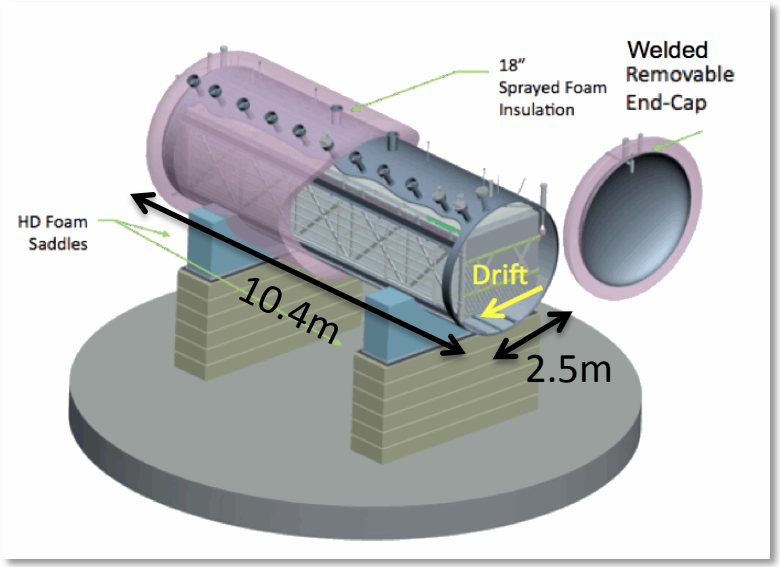
January 23, 2014

Outline

- •MicroBooNE overview
  - Collaboration
  - Project Status
- •MicroBooNE recent accomplishments
  - Final assembly of the TPC
  - PMT installation
  - TPC Installation
  - LArTF
  - Transition to Operations
    - Commissioing
    - Data taking
    - Software and Reconstruction

MicroBooNE



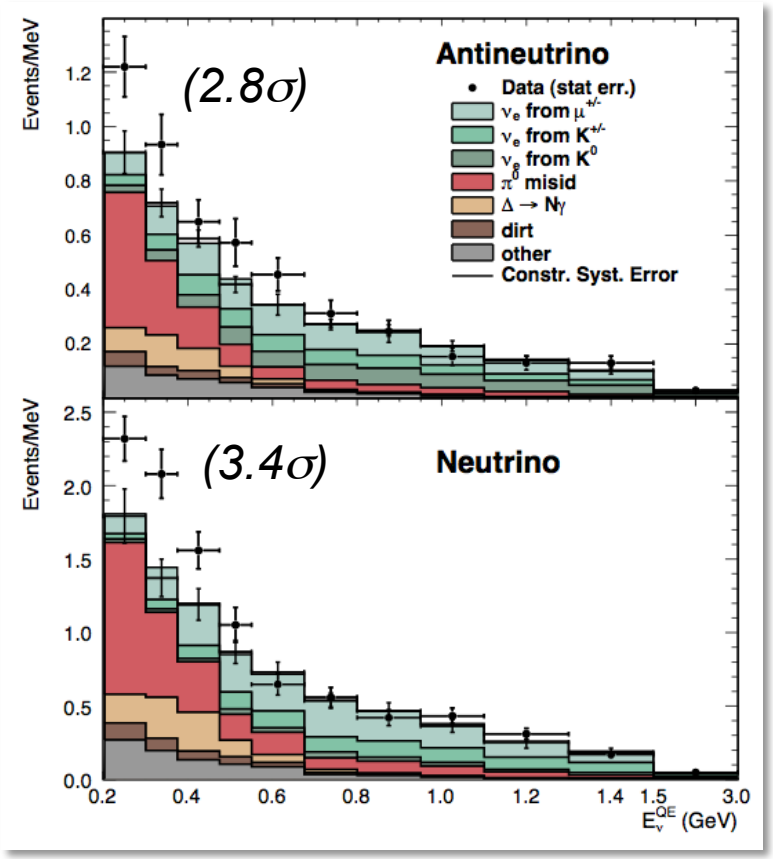


- 170 ton LAr TPC
  - *same beam & location as MiniBooNE*
  - *new detector technology*
- goals:
  - *MiniBooNE excess events*
  - *σ_ν measurements in argon*
  - *R&D for future LAr TPCs*

Motivation = MiniBooNE Excess

- MiniBooNE has published ν_e and $\bar{\nu}_e$ results with the entire data set

(Aguilar-Arevalo et al., Phys. Rev, Lett. 110, 161801 (2013))

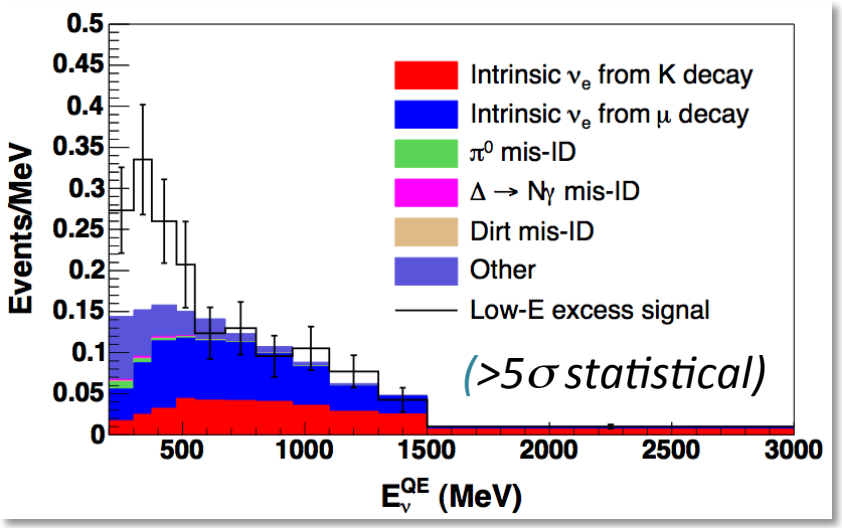


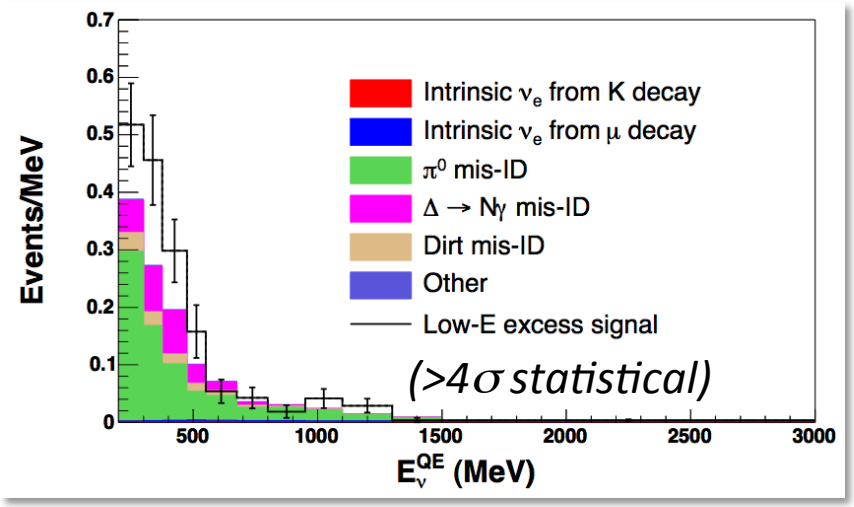
- observe an excess of low energy events in both running modes
- source of the excess is unknown (MicroBooNE!)
- both outcomes are interesting

γ (background)

e^- (signal)

MicroBooNE



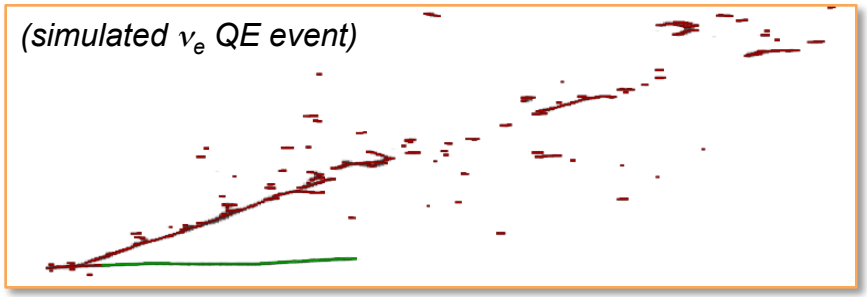


(projections for 6.6x10^{20} POT = 3 years)

- unlike MiniBooNE, MicroBooNE can distinguish e$^-$'s from γ's

if assume an <u>electron signal</u> and have analyzed for an e$^-$

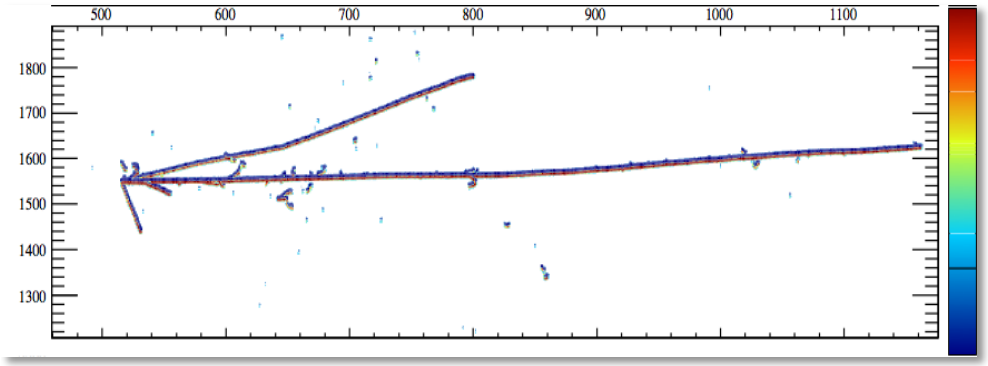
if assume a <u>photon background</u> and have analyzed for a γ



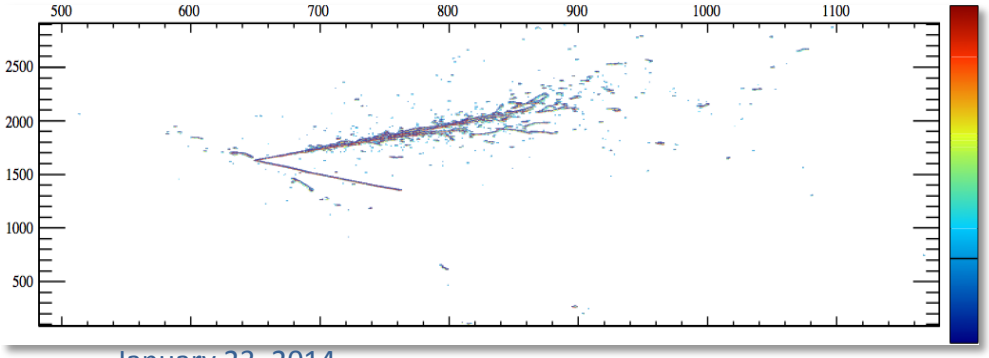
B. Carls (FNAL)

MicroBooNE Cross Sections

- will more precisely examine final states produced in ν interactions by exploiting LAr TPC capabilities and building off of what we've learned in both MiniBooNE & ArgoNeuT



(simulated ν events in MicroBooNE)



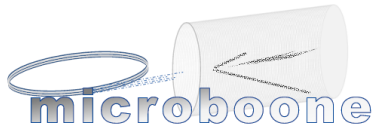
	BNB	NuMI
Total Events	145k	60k
ν_μ CCQE	68k	25k
NC π^0	8k	3k
ν_e CCQE	0.4k	1.2k
POT	6×10^{20}	8×10^{20}

Projected Event Rates for MicroBooNE in 2-3 years.

- MicroBooNE will make first σ_ν measurements in argon at low neutrino energies (~1 GeV)
- these analyses will benefit from well-known Booster neutrino flux

Aguilar-Arevalo et al., PRD 79, 072002 (2009)

R&D

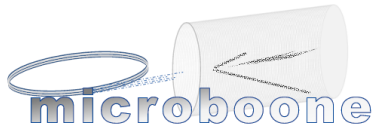


- MicroBooNE detector is not a pure prototype for LBNE; however, it incorporates several major advances which are important "proofs of principle" for next generation large detectors:

  - *non-evacuated cryostat*
  - *cold (in liquid) electronics*
  - *2.5 meter drift*

- Gaining experience in design and fabrication details, costing, etc.
- Additionally, MicroBooNE will collect a large data set of ν events which will be used to develop fully automated event reconstruction

MicroBooNE Collaboration



Brookhaven: M. Bishai, H. Chen, K. Chen, S. Duffin, J. Farrell, F. Lanni, Y. Li, D. Lissauer, G. Mahler, D. Makowiecki, X. Qian, J. Mead, V. Radeka, S. Rescia, A. Ruga, J. Sondericker, C. Thorn, K-C. Wu, B. Yu

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University of Chicago: W. Foreman, Johnny Ho, D. Schmitz, J. Zennamo

University of Cincinnati: R. Grosso, J. St. John, R. Johnson, B. Littlejohn

Columbia University: N. Bishop, D. Caratelli, L. Camilleri, C. Chi, J. Dickinson, D.Garisto, D. Kaleko, G. Karagiorgi, B. Seligman, M. Shaevitz, B. Sippach, K. Tatem, K. Terao, B. Willis

Fermilab: R. Acciarri, B. Baller, D. Bogert, B. Carls, M. Cooke, H. Greenlee, C. James, E. James, H. Jostlein, M. Kirby, S. Lockwitz, B. Lundberg, A. Marchionni, S. Pordes, J. Raaf, G. Rameika, B. Rebel, A. Schukraft, S. Wolbers, T. Yang, G.P. Zeller*

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University of Oxford: G. Barr, R. Guenette

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Saint Mary's University of Minnesota: P. Nienaber

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University of Texas at Austin: S. Cao, J. Huang, K. Lang, R. Mehdiyev

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INFN, Italy: F. Cavanna, O. Palamara *(currently at Yale)*

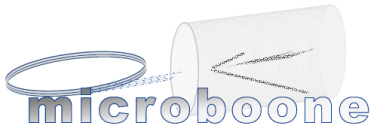
Virginia Tech: M. Jen, L. Kalousis, C. Mariani

Yale University: C. Adams, E. Church, B. Fleming*, A. Hackenberg, K. Partyka, A. Szelc

120 collaborators from 21 institutions, 24 postdocs, 15 grad students

* spokespeople

MicroBooNE Collaboration



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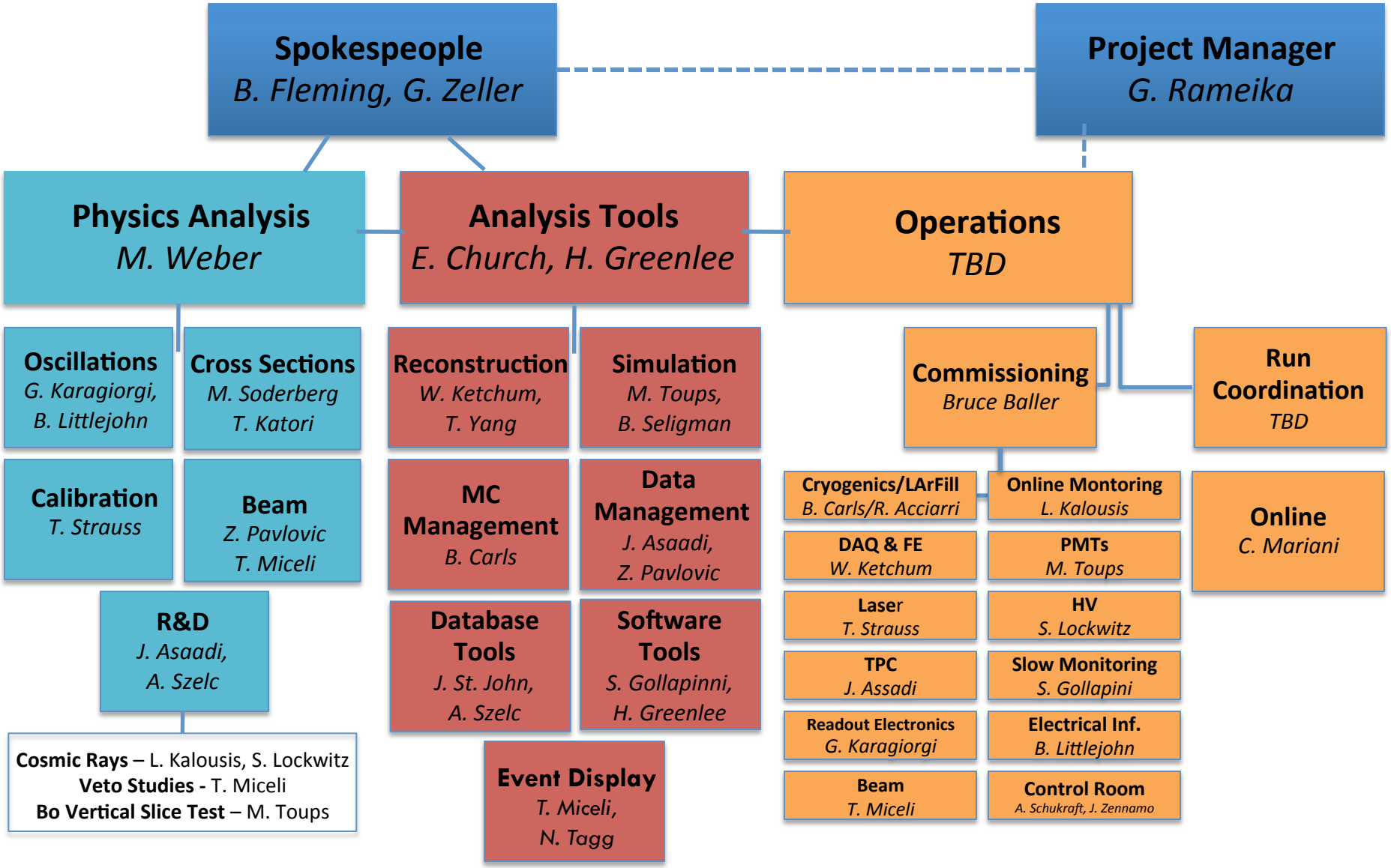
New Collaborators:
SLAC
Oxford
Cambridge
Pittsburgh

* spokespeople

Collaboration Organization



MicroBooNE project

The WBS Dictionary describes the scope of each

WBS 1.1
Project
Management

WBS 1.5
Front-end Electronics
WBS 1.11
Electronics Readout

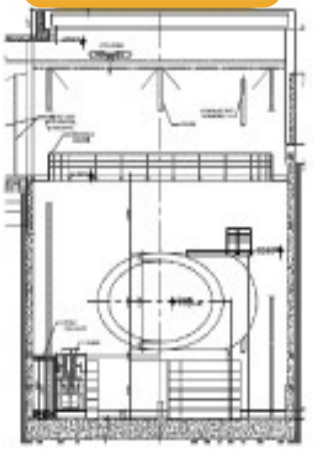
WBS 1.6
Experiment
Infrastructure

In LArTF

WBS 1.3
Cryostat

WBS 1.2
Cryogenics
Systems

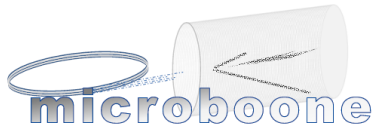
WBS 1.4
Time Projection
Chamber



WBS 1.7 Systems Installation
WBS 1.9 DAQ, Monitoring, and Control
WBS 1.10 Detector Assembly Integration

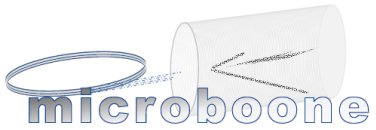
WBS 1.8
PMT System

MicroBooNE Project Milestones



- CD-0 Mission Need : September 2009
- CD-1 Alternative Selection and Cost Range : June 2010
- CD-2/3a Performance Baseline : September 2011
- CD-3b Begin Full Construction : March 2012
- CD-4 Begin Operations :
  - Working date : mid-2014
  - DOE CD-4 milestone – September 2015 (from PEP)

MicroBooNE Project Milestones



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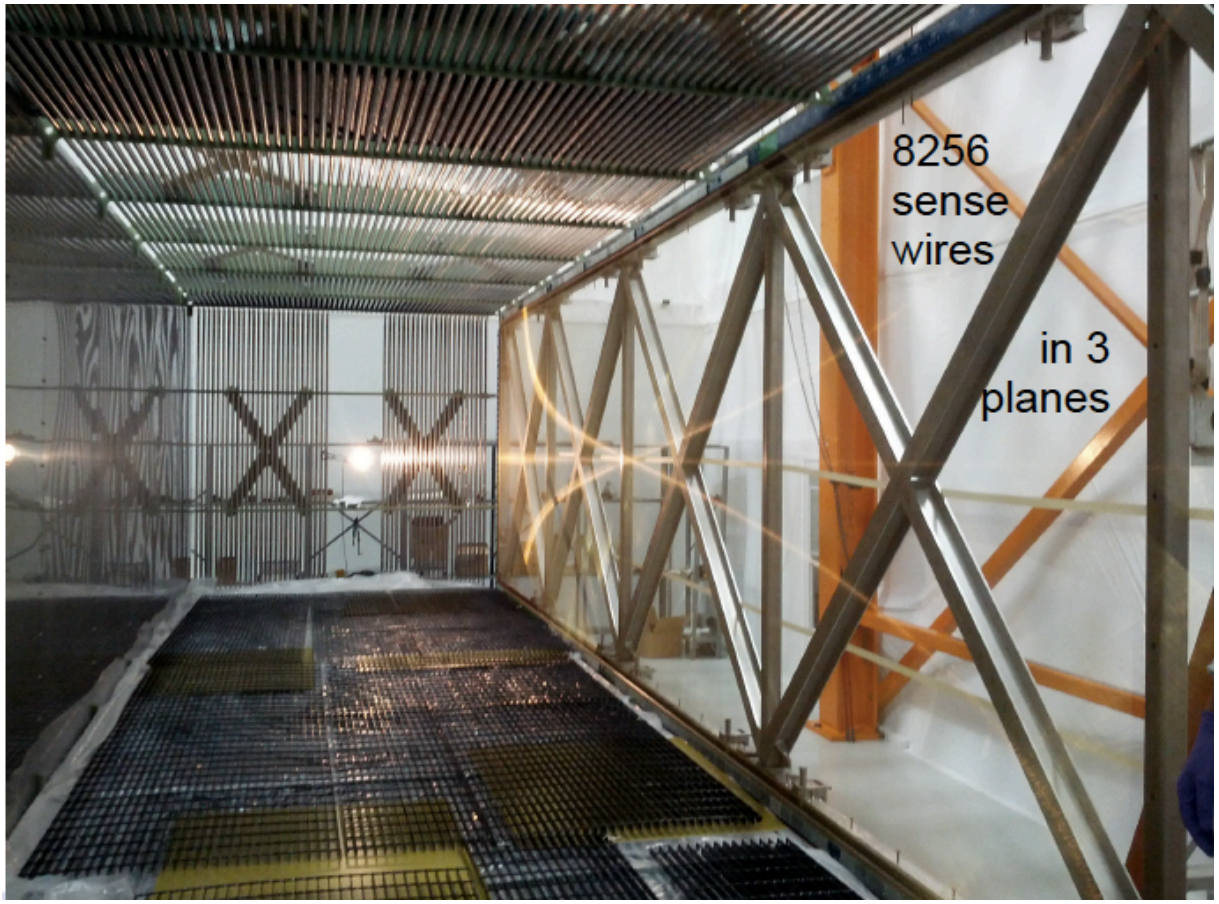
- Final Assembly of all systems
- Infrastructure at LArTF
- Transport detector to LArTF
- Transition to Operations

TPC Final Assembly (all wires strung by May 2013)



TPC assembled and wire stringing complete in May 2013

In progress Task List

Red = DONE

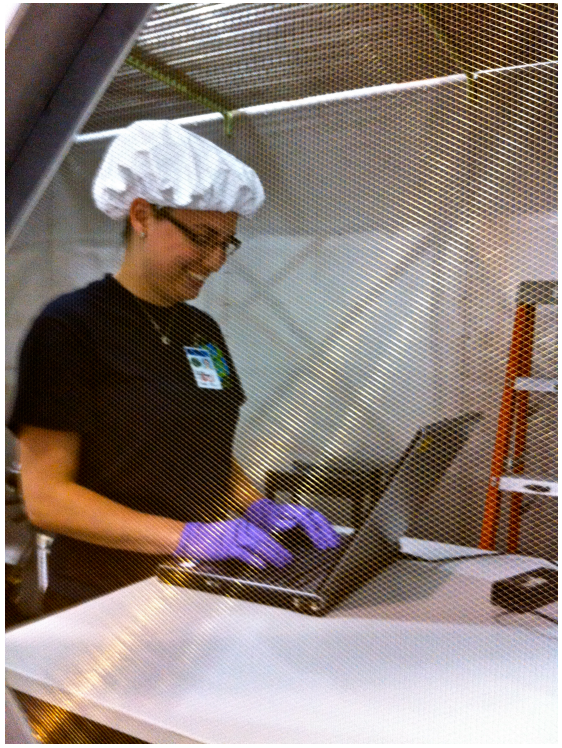
- Tasks at DAB
  - Install cable tray and cold cables
  - Wire tension measurements (all wires)
  - Cold electronics installation and testing
  - Final survey of TPC
  - Install final field cage tubes
  - Install RTDs on TPC
  - Install PMT array
  - Insert TPC in cryostat
  - Connect cold cables
  - Final checks
  - Weld endcap
- Tasks at LArTF
  - Complete Phase-1 cryo piping
  - Install vessel
  - Insulate vessel
  - Install platform & racks
  - Cabling and test readout
  - Install Phase-2 cryo (compressor & cool-down)

Activities accomplished through Project teams and Task Forces (experts + "new eyes")

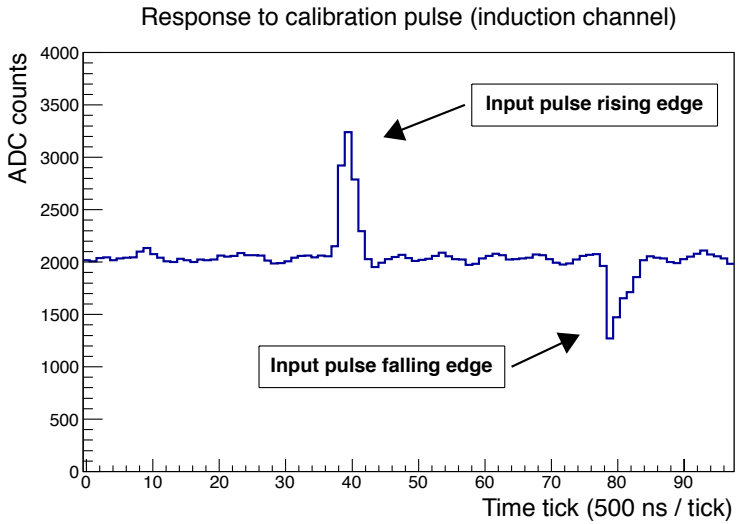
- Task Forces (in progress) :
  - TPC Final Modifications
  - High Voltage Feed-through
  - Detector operating parameters
  - Measurement of HV properties of Lar
  - Readiness for ORC

Wire tension measurements

- MicroBooNE students/postdocs and teacher interns (FNAL TRAC program) helped immensely with these measurements and with analyzing the data.
  - Great summer project!
- Completed measurement of ***all wires*** (in tolerance) this fall



DAB: Testing electronics

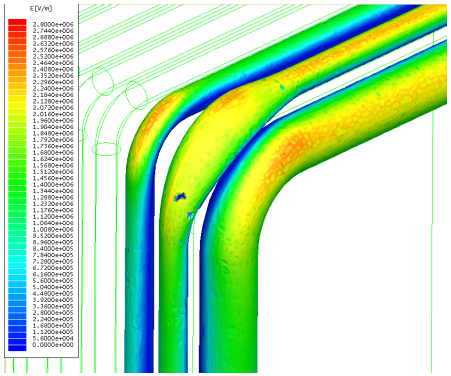


- All cold motherboards installed and tested with this summer -- DONE
- Test pulse injected to boards, readout by mobile readout crate + DAQ -- DONE
- After cold cables are pulled through chimneys and attached to feedthrough, same tests will be done -- DONE

TPC final assembly

- TPC modifications to increase safety factor against HV breakdown
  - Modification of final field cage loops
  - Modification (smoothing) of some joints
    - Cathode plane
    - Field cage
    - Final checks
      - *In progress*

DONE



Softer bend radius on corner field cage tubes

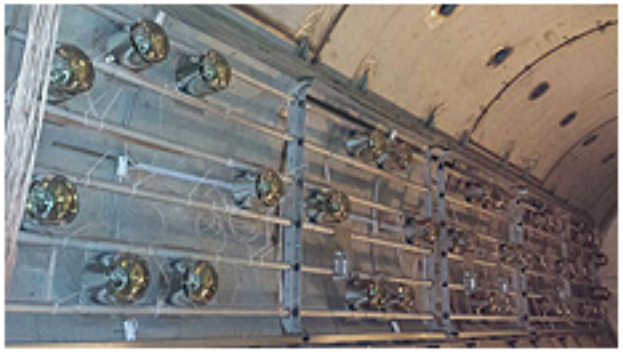
Smooth joints with welds on Cathode Plane

PMT final assembly

Final Assembly of PMT array and Installation in the detector
September 2013

Construction Update

Optical system installed in MicroBooNE detector



MicroBooNE's optical system, which captures and measures light resulting from particle interactions, was recently installed in the experiment's detector. *Photo: Matt Toups, MIT*

Installation in the Cryostat

Feature — Fermilab Today

MicroBooNE installs time projection chamber inside vessel, prepares for move

December 20 2013

LArTF

At LArTF

- Phase 1 Cryo testing in progress
- HV Cryostat
  - Production Feed-through is ready for testing
  - All parts for breakdown test assembled
  - Stand alone filling in progress
- Will operate Phase I and tests until we are ready to install the detector (~beginning of March)

Transition to Operations

- Well integrated project team and collaboration
- Many folks playing roles on project are transitioning to Commissioning phase

- Commissioning
  - Team Leader: Bruce Baller
  - Teams for each system led by expert PDs and faculty level advisors (outside of their area – “new eyes”)
  - Planning underway now as pre-commissioning completes

Transition to Operations

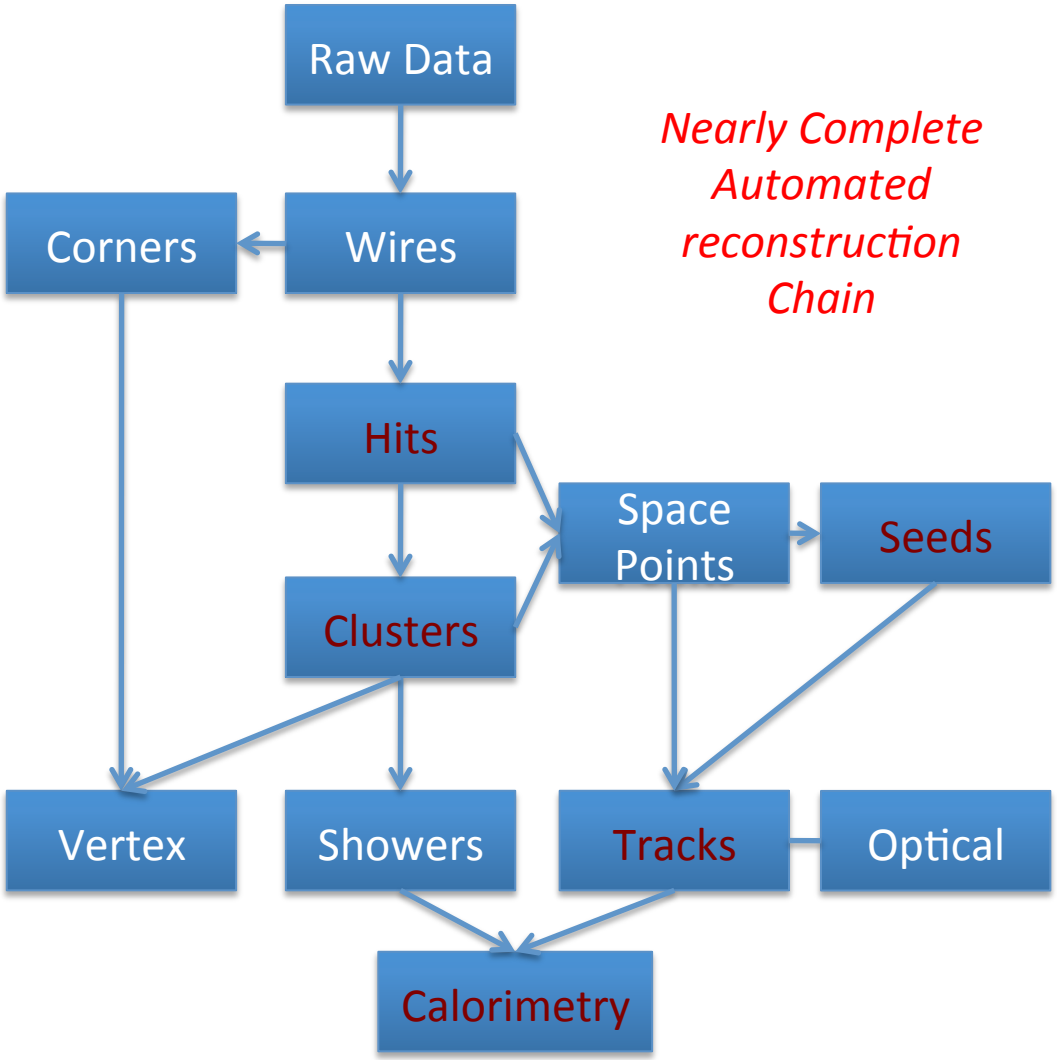
Team	Leader
Cryogenics / LAr Fill	Ben Carls / Roberto Acciarri
DAQ & FE	Wes Ketchum
Laser	Thomas Strauss
TPC	Jonathan Asaadi
Readout electronics	Georgia Karagiorgi
Beam	Tia Miceli
Online monitoring	Leonidas Kalousis
PMTs	Matt Toups
HV	Sarah Lockwitz
Slow monitoring	Sowjanya Gollapini
Electrical infrastructure	Bryce Littlejohn
Control room	Anne Schukraft, Joseph Zennamo

Analysis Tools

Analysis Tools sub-groups in place and developing tools since May

- Regular MC challenges
- Progress on Reconstruction/ simulation/software tools
- Thinking about first plots and first analyses

Reconstruction Development



Nearly Complete Automated reconstruction Chain

Simplified version

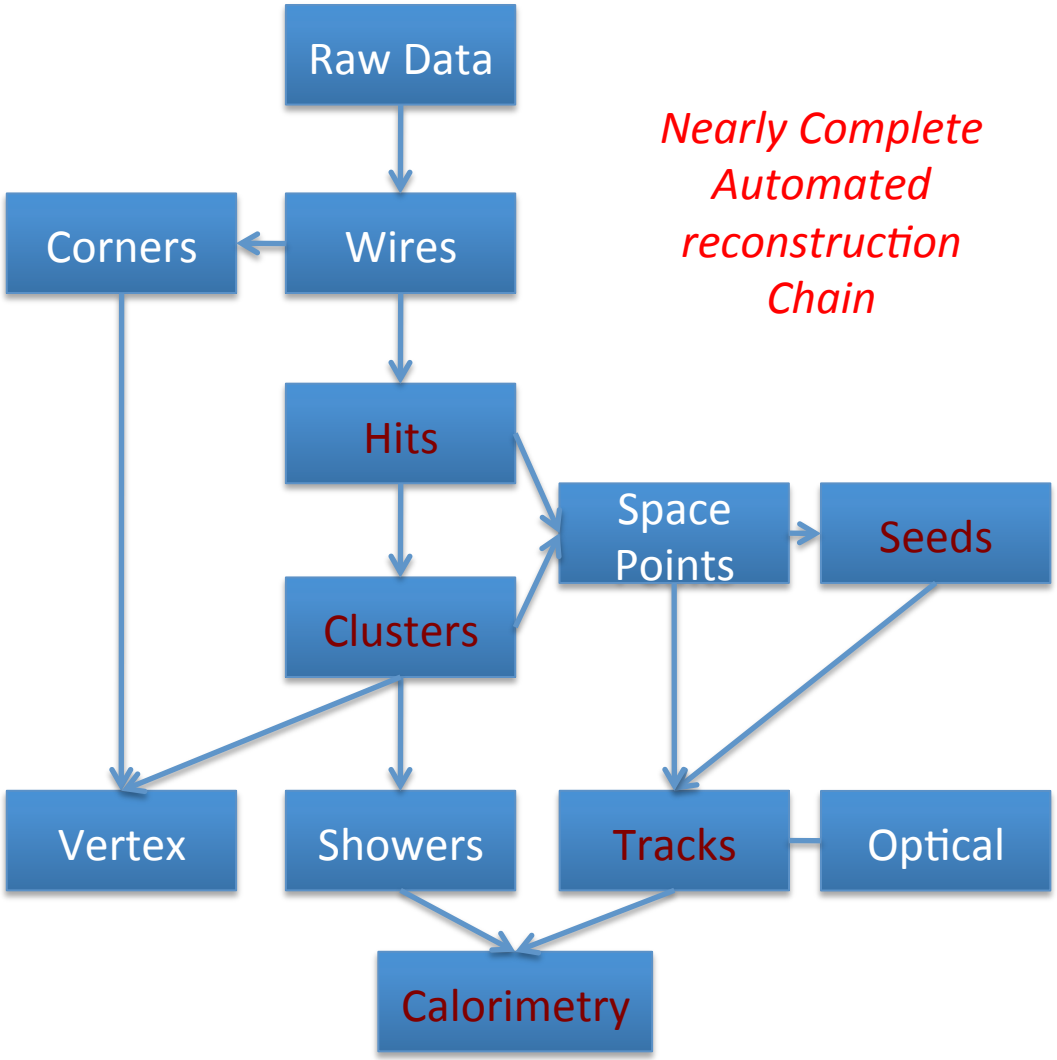
Feature Fermilab Today

MicroBooNE, in 3-D

Tingjun Yang (left) and Wesley Ketchum lead the effort to develop new 3-D reconstruction software for the MicroBooNE experiment. Here they stand inside the MicroBooNE time projection chamber. *Photo: Reidar Hahn*

- Pandora is being integrated into LArSoft
- Optical reconstruction is being developed
- Significant work on shower reconstruction

Reconstruction Development



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Reconstruction Workshop last November

Reconstruction "retreat" this March

Conclusions

- Final pre-commissioning work underway
- Detector to move to LArTF in early March
- Transition to Operations underway
  - Commissioning Team planning commissioning phase
  - Nearly complete Reconstruction chain
  - Readying for Operations

Great team of people – new collaborators, students and post-docs, well integrated collaboration and project team

•Ready for neutrino beam when detector is commissioned: 2.2E20 POT/year for 3 years